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In Reply Refer To:
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RCA:MK:ch
22 April 1964

Subject: Submittal of Monthly Progress Report for Contract NAS 1-2934

To: National Aeronautics and Space Administration
Langley Research Center
Langley Station
Hampton, Virginia 23365

Attention: Contract NAS 1-2934

Enclosure: A) Ten (10) copies of Monthly Progress Report for Period of 11 March 1964 to 10 April 1964

1. The tenth monthly progress report is submitted herewith in accordance with requirements of Specification Number L-2890-A.

R. C. Armstrong

R. C. Armstrong, M.D.
Project Manager
Life Support System

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Life Support System

GENERAL DYNAMICS/ASTRONAUTICS
Life Support Project
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21 April 1964

LIFE SUPPORT SYSTEM FOR SPACE FLIGHTS OF EXTENDED TIME PERIODS

Contract NAS 1-2934

MONTHLY PROGRESS REPORT

For Period of 11 March 1964 to 10 April 1964

Prepared for

NASA Langley Research Center
Langley Station
Hampton, Va.

Prepared by D. Krause
D. Krause
Deputy Project Manager

Approved by R. C. Armstrong, M.D.
R. C. Armstrong, M.D.
Project Manager

CURRENT ACTIVITIES

1.0 GENERAL

1.1 A preliminary draft of the LSS integrated test program was completed.

1.2 North American Aviation engineering personnel were questioned regarding the use of 3M series 400 paint for the Apollo interior. They confirmed that they are using this paint and that it apparently has the least material outgassing of several paints considered. It has been recommended to NASA/Langley that we consider this paint for our program.

1.3 An integrated pressure suit LSS configuration was investigated. A report has been written and transmitted to NASA.

1.4 A design review of TRW's water separator was accomplished. Authorization was given to TRW to procure and fabricate all auxiliary items of the water separator system except the water separator module.

2.0 THERMAL CONTROL

2.1 Report 64-26208, "Thermal Control Analysis" and Report 64-26207, "Thermal Control Subsystem Specification", have received a final check and are ready for final approval and reproduction. These reports reflect changes in component thermal control requirements which were current at the time the revision was started. These changes resulted in some significant revisions in the methods of thermal control. More recent changes are not included, but they are of lesser significance and are not expected to change any of the methods or concepts.

2.2 The cabin air heat exchanger proposals submitted by the following vendors were evaluated:

Hamilton Standard
United Aircraft Products
Fairchild Stratos
AiResearch

The units proposed by Hamilton Standard and United Aircraft Products were inadequate in performance for the LSS requirements. The unit proposed by Fairchild Stratos was not applicable for the use intended. AiResearch proposed a unit consisting of four cores of existing design manifolded together to form a single unit. The capacity of this unit was marginal with respect to the LSS requirements and the modular construction did not represent an optimized configuration for the application intended.

A commercial heat exchanger manufacturer was contacted to determine the feasibility of having a unit built to meet our specifications. The unit dimensions and geometry were determined from the performance characteristics of a similar unit used for previous in-house manned space station testing. This commercial heat exchanger will be typically larger and heavier than a flight design.

Agreement was reached between Astronautics and NASA (Frank Booth) to procure this commercial heat exchanger rather than an off-the-shelf core designed for aircraft application. This decision was made because none of the proposed units were optimized for our conditions and the cost difference between the proposed and commercial heat exchangers were considerable.

2.3 Revised thermal requirements obtained from LSS component manufacturers' are being reviewed. These changes are being incorporated into the thermal control system to insure compatibility.

2.4 A design review of the Hohanson cooling and pumping unit and the heating and pumping unit was held. The designs were approved as modified and fabrication of the units has started.

2.5 A commercial type temperature control manufactured by Minneapolis Honeywell was reviewed with NASA (Frank Booth). This type will be used in the system in the interest of saving costs.

2.6 The off-the-shelf temperature controller by Minneapolis Honeywell contains a bellows which makes the unit unsuitable for the LSS. The Honeywell representative suggested another one of their units which is electrically controlled and unaffected by changes in ambient pressure. This unit is now under investigation.

3.0 ATMOSPHERIC CONTROL

3.1 A conference was held at NASA Houston to discuss the potential problem of degradation and resulting short life of the G.E. electrolysis cell membranes. Representatives from NASA/Houston, NASA/Langley, GD/A and G.E. were present. The detailed proceedings of this conference are reported in a GD/A memo by G. L. Drake dated 31 March and a GD/Electric Boat Memo by Dr. O. L. I. Brown dated 3 April. In general, the conferees concluded that the membrane degradation experienced in fuel cells should not be a problem in electrolysis cells, which operate under different conditions.

Dr. Brown did express concern over a possible concentration gradient in the stagnant electrolyte chambers of the G.E. cells. Such a gradient would increase the voltage and power requirements of the cells. G.E. was contacted regarding this problem and stated that they will check this point in their preliminary test cell stack.

3.2 The final design review of the reduction unit was held with TRW on April 6 and 7. The details of the meetings are included in the published minutes. Some of the more pertinent points include:

1. Due to the wet H_2 entering the unit, the inlet gases will be introduced upstream of the condenser separator in the recycle loop.

2. The pre-cooler will be left in the recycle loop but will not be used unless it is found to be needed later.

3. System shut-down provisions were added to account for the critical failures which could be foreseen by the conferees. Added items include: (a) compressor failure shut-down, and (b) reactor temperature rise shut-down.

3.3 Integration and control studies of the oxygen reclamation system have continued. As the individual units are becoming better defined, recommendations regarding the interfaces are being made to G.E., TRW and Hamilton Standard. It currently appears that no active process control mechanisms are required between the three units. The reduction unit is designed to accomplish the control internally since it only functions when either CO_2 or H_2 are available. The concentrator will merely process all the CO_2 produced by the men. The electrolysis unit continuous process rate must be set to match the net CO_2 reduction rate, but it currently appears that this is feasible. More than 15% excess H_2 is produced when the match is achieved and therefore the electrolysis unit need only be adjusted on a short-term basis within the 15% margin. The long-term electrolyzer adjustment to produce the required O_2 can be made manually.

3.4 A layout of the charcoal filter and return air grill assembly was completed and a design review held. The air cooled electronic equipment simulator had been incorporated as part of the unit. Decision was made to remove the simulator to preclude possible heat damage to the charcoal filter. The assembly is being redrawn to incorporate the required changes.

3.5 Preliminary air distribution system arrangement sketches (59$\frac{1}{4}$-2-25) were forwarded to obtain approval on the air distribution concept.

4.0 FOOD, WATER, WASTE AND PERSONAL HYGIENE

4.1 Two food storage modules of approximately 5 ft. long x 6 ft. high x 18" deep were requested from Whirlpool rather than a single storage rack.

4.2 Apparent problem areas and matters requiring clarification in the air evaporation system have been presented to and discussed with Hamilton Standard. Answers have not yet been received on the following matters:

1. Problems concerning storage of hydrogen peroxide. Method of measuring and injecting H_2O_2 into system.
2. Cooling fluid requirements for water recovery rate of 1.65 lbs/hr.
3. Maximum and minimum amount of $CuSO_4$ required as pretreatment chemical.
4. Method of measuring and injecting $CuSO_4$ into waste waters.

4.3 A report on the functional operation of the water management system was prepared and submitted to NASA.

4.4 The water storage tank design (Astronautics) was reviewed and approved for fabrication at Astronautics.

4.5 The revised water management subsystem specification was typed in final form.

4.6 Work has commenced on the water management subsystem failure analysis.

4.7 Electric Boat's filtration unit design was approved with the exception of the physical arrangement of the canisters. A revised arrangement of the canisters (decreasing the length of the unit) was incorporated in the final design. The liquid-gas separator was removed from the unit since it is planned to store filter canisters with water so that no air carry over in the product stream will result.

4.8 Layouts of the sponge squeezer and moistener were completed. Layouts of the personal hygiene facility were started.

4.9 A report - 64-26219, Water Management Subsystem Operation Description - was made and submitted. This report was a detailed description of how the GD/A furnished valves were to be manipulated to obtain the various transfer routes required for the different routine and failure conditions.

4.10 A rough handmade RTV60 and fiberglass cloth water tank diaphragm was made in the development lab by GD/A for the purpose of running an expulsion efficiency test on this tank and bladder configuration. The bladder was heavy and thick and therefore the test was conservative. The quantity of water was carefully measured and poured into the tank. The air side of bladder was pressurized to 1 psi and the expelled water was again measured. 99.6% of the water was expelled by the bladder.

5.0 CONTROLS & INSTRUMENTATION

5.1 The life support system instrumentation and control detail requirements have been compiled and assembled into a report, 64-26140, Status Panel and Ground Control Console Equipment as well as subsystem control panel equipment is called out. This report will be reproduced and submitted by the week of the 20th of April. Changes to the instrumentation and control system as required by subsystem revisions during development will be reflected in this report as required.

6.0 TEST BED

6.1 The test bed was assembled and moved into the high bay area of the test lab at GD/A. The high vacuum structural tests were run satisfactorily on the main tank and airlock. Leakage tests were run on the cabin area and found to meet the spec requirements. On conculsion of the tests, it was found that the handle mechanism bearing area was unsatisfactory. CB&I agreed to rework the handle for better bearing necessitating a rerun of the main tank leakage test.

6.2 An external stores drawing was made for purposes of providing equipment for a preliminary tank pressurization test. This test will be designed to set up a procedure for maintaining the required tank pressure and O_2 and N_2 partial pressures. The drawing will be modified to provide the external stores as required by the test bed leakage rates determined during the leakage tests.

6.3 The test bed hatch safety devices were reviewed with NASA and agreements on modifications to the hatch systems were reached. In general, the hatch systems eliminated all electrical and automatic devices putting the emphasis on manual equipment and properly trained personnel.

6.4 The test bed had been painted inside and out with zinc chromate primer per spec requirements. A subsequent finding indicated that this paint represented a potential hazard. This problem was discussed with Frank Booth and Dr. Newsom, GD/A Aerospace Medicine Group. The total toxic problem is not known at this time, however on the basis of the possibility of a toxic problem it was agreed that the zinc chromate would be removed by sand blasting and replaced with an approved paint. A 3M 400 series paint is being investigated since there has been considerable work done on this for the Apollo program. Subcontractors have been contacted for the paint removal and repainting work which will be accomplished after the hatch mods have been completed.

WORK PLANNED FOR NEXT MONTH

1. Thermal control coordination with subcontractors of other components and subsystems will be continued.

2. An O_2-CO_2 control procedure will be formulated.

3. An interface flow schematic pertinent to the O_2 reclamation system control function will be formulated and sent to NASA.

4. A design review with G.E. on the electrolysis unit is scheduled to be held.

5. A preliminary design review will be held with Whirlpool on the food management system.

6. A final design review of MRD's waste management system and a preliminary design review of the toxin burner will be made.

7. The problems associated with the air evaporation unit and the CO_2 concentrator will be investigated during a trip to Hamilton Standard.

8. Tank modification to rework the hatch safety mechanism will be completed prior to sand blast and painting.

9. Test bed equipment rack arrangement layout will be refined with information from vendors on interface connections.

10. Water management equipment rack arrangement layouts will be continued.

11. Hygiene area arrangement layouts will be continued including detailed layout of sponge squeezer.

12. Instrumentation JPL's will be prepared and held for NASA's approval of the instrumentation summary.